ATOMTEX

Scientific and Production Enterprise

Radiation monitors

AT6130, AT6130A, AT6130B

Manual

Table of contents

1 DESCRIPTION AND OPERATION 5
1.1 PURPOSE 5
1.2 TECHNICAL SPECIFICATION 7
1.3 RADIATION MONITOR COMPLETE SET 13
1.4 DESIGN AND OPERATION 14
1.5 RADIATION MONITOR DESIGN 15
1.6 MARKING AND SEALING 17
1.7 PACKING 18
2 PREPARATION TO OPERATION 19
2.1 GENERAL INSTRUCTIONS 19
2.2 BATTERY SETTING 19
2.3 SWITCHING-ON AND OFF 20
3 MONITOR USE 21
3.1 CONTROL FUNCTIONS 21
3.2 MEASURING INDICATION MODE 24
3.3 MENU MODE 25
3.4 DOSE RATE 30
3.5 DOSE 31
3.6 FLUX DENSITY 32
3.7 BACKGROUND 34
3.8 THRESHOLD 34
3.9 SEARCH 36
3.10 NOTEBOOK 38
3.11 DIAGRAMS 39
3.12 DATE AND TIME 42
3.13 IR PORT 43
3.14 DECONTAMINATION 48
3.15 THE LIST OF POSSIBLE TROUBLES 49
4 TECHNICAL SERVICE 50
5 STORAGE 51
6 TRANSPORTATION 52

7 UTILIZATION 52

8 ACCEPTANCE-CERTIFICATE 53

9 PACKING LIST 54

10 WARRANTY 55

11 RECLAMATION 56

APPENDIX A
STANDARD ENERGY SENSITIVITY RESPONSE RESPECT TO ^{137}CS GAMMA RADIATION ENERGYOF 662 KEV 58

APPENDIX B
STANDARD SENSITIVITY RESPONSE UPON MAXIMUM BETA-SPECTRUM ENERGY AT MEASURING BETA RADIATION FLUX RATE 59

APPENDIX C
STANDARD SENSITIVITY RESPONSE UPON GAMMA RADIATION INCIDENCE ANGLE RESPECT TO THE CALIBRATION DIRECTION 60

APPENDIX D
DEPENDENCE OF LOW LIMIT OF BETA RADIATION FLUX RATE MEASURING ON BACKGROUND AND FLUX DENSITY MEASURING TIME 62

The present Manual describes the operation, design and construction of radiation monitors **AT6130, AT6130A** and **AT6130B**. It includes the main technical specification and other information for the correct and full functional use of their possibilities.

The manufacturer has the right to make changes in the design and software of radiation monitors that do not affect its metrological characteristics.

In the text of the present Manual you can find the following abbreviations:

LCD – liquid crystal display;
IR – infrared port;
PC – personal computer.

1 Description and operation

1.1 Purpose

1.1.1 Radiation monitors **AT6130**, **AT6130A** and **AT6130B** (hereinafter referred as to instruments) are intended to:

- measure ambient X-ray and gamma radiation dose rate $\dot{H}^*(10)$ (hereinafter referred as to dose rate);
- measure ambient X-ray and gamma radiation dose $H^*(10)$ (hereinafter referred as to dose);
- measure beta radiation flux density emitted from contaminated surface **(only AT6130)**;
- search ionizing radiation sources and radioactive materials.

Features of the instruments are given in Table 1.1.

Table 1.1

Description	**AT6130**	**AT6130A**	**AT6130B**
Beta radiation flux density measuring	+	–	–
X-ray and gamma radiation dose and dose rate measuring	+	+	+
IR port (IrDA)	+	–	+

1.1.2 The radiation monitors are hand-held instruments. They can be used under field and laboratory conditions by radiation safety bodies, at enterprises dealing with ionizing radiation sources and to control exposure dose of working with ionizing radiation sources medical staff.

1.1.3 Operational radiation monitor conditions are:

- ambient air temperature:
  AT6130, AT6130B from -20 to +55 °C;
  AT6130A ***with data indication***
  from -20 to +55 °C;
  AT6130A ***without data indication***
  from -40 to +55 °C;
- relative humidity at temperature of 35 °C and lower without moisture condensation up to 95 %;
- atmosphere pressure from 84 to 106.7 kPa;
- magnetic intensity up to 400 A/m.

1.1.4 Reference radiation monitor conditions are:

- ambient air temperature (20 ± 5) °C;
- relative humidity 60 (+20; –30) %;
- atmosphere pressure 101.3 (+5.4; -15.3) kPa;
- magnetic intensity 40 A/m.

1.1.5 The water tightness is IP65 according to IEC 529-89 International standard requirements.

1.1.6 The radiation monitors are not intended for operation in explosive areas according to rules of electrical device design.

1.1.7 The instruments meet IEC 60846 2002-06 International standard requirements.

1.2 Technical specification

1.2.1 The instruments measure:

- gamma radiation dose rate in the range from 0.1 µSv/h to 10 mSv/h;
- gamma radiation dose in the range from 0.1 µSv to 100 mSv;
- beta radiation flux density emitted from contaminated surface in the range from 10 to 10^4 part/(min·cm^2) **(only AT6130)**.

1.2.2 The energy range of detected gamma radiation:

AT6130: from 20 keV to 3 MeV;
AT6130A: from 60 keV to 3 MeV;
AT6130B: from 60 keV to 3 Mev.

The energy response in the energy range of detected gamma radiation respect to the gamma radiation energy of 0.662 MeV (^{137}Cs) does not exceed ±25 %. Graphs of standard energy response are given in Appendix A.

1.2.3 The energy range of detected beta radiation **(only AT6130)** is from 300 keV to 3.5 MeV. The energy response in the energy range of detected beta radiation respect to the beta radiation energy of ^{90}Sr+^{90}Y is from +50 % to -60 %. The graph of standard energy response is given in Appendix B.

1.2.4 The instrument sensitivity response upon gamma radiation incidence angle respect to the calibration direction, which is perpendicular to the radiation monitor line of symmetry (anisotropy), does not exceed:

- gamma radiation source (22 keV) of $^{109}\mathrm{Cd}$ in angles **(only AT6130)**:

from 0 to 45°	not more than 50 %;
from ± 45° to ± 60°	not more than 70 %;
from ± 60° to ± 180°	not normalized;

- gamma radiation source (59.5 keV) of $^{241}\mathrm{Am}$ in angles:

from 0 to 45°	not more than 40 %;
from ± 45° to ± 60°	not more than 60 %;
from ± 60° to ± 90°	not more than 65 %;
from ± 90° to ± 180°	not normalized;

- gamma radiation source (662 keV) of $^{137}\mathrm{Cs}$, (1250 keV) of $^{60}\mathrm{Co}$ in angles:

from 0 to 45°	not more than 20 %;
from ± 45° to ± 60°	not more than 25 %.
from ± 60° to ± 90°	not more than 40 %.
from ± 90° to ± 180°	not more than 50 %.

Graphs of standard anisotropy are given in Appendix C.

1.2.5 The limits of tolerated relative intrinsic error of gamma radiation dose rate measurement are ± 20 %.

1.2.6 The limits of tolerated relative intrinsic error of beta radiation flux density measurement are ± 20 %.

1.2.7 The measurement time of natural background (0.1 μSv/h) at statistical error of ± 20 % does not exceed 300 s.

1.2.8 Following fixed thresholds are specified automatically at switching-on:

30 μSv/h as a dose rate threshold;
180 μSv as a dose threshold;
100 part/(min·cm^2) as a flux density threshold.

It is possible to change thresholds in the manual mode according to the chain of fixed values divisible by 1.0, 1.5, 2.2, 3.3, 4.7, 6.8 within the dose rate measuring range from 0.1 μSv/h to 10 mSv/h; the dose measuring range from 0.1 μSv to 100 mSv and the flux density measuring range from 10 to 10^4 part/(min·cm^2).

1.2.9 The instruments tolerate 10-times exceeding of the upper limit of dose rate measurement range or beta radiation flux density measurement range for 5 min with continuous indication of at least the upper measurement range limit. The time to restore the operability does not exceed 5 min.

1.2.10 It is possible to save up to 1000 measurement results in the memory, keep (when the power is off or on) and view them (the notebook mode) in the manual mode. In the automatic mode it is possible to save up to 1000 dose rate measurement results with fixed measurement time of 6, 60 or 600 s, keep (when the power is off or on) and view them (the diagrams mode).

1.2.11 The radiation monitors **AT6130** and **AT6130B** has the possibility of data exchange with PC by IrDA interface (modes: notebook, diagrams).

1.2.12 The instruments perform self-testing of their main modules at switching-on and continuous testing of their operability during operation.

1.2.13 The instruments supply from two batteries, type AAA, rated voltage of 1.5 V each.

Note *- The instruments can supply from two accumulators, type AAA, rated voltage of 1.2 V each.*

1.2.14 The continuous operation time from one battery set (two batteries, rated voltage of 3 V, rated capacity of 1.1 A·h) is at least 500 h at background radiation. The required current does not exceed 2 mA.

1.2.15 The instruments have automatic discharge control.

1.2.16 Operation mode setup time does not exceed 1 min.

1.2.17 The reading instability for continuous operation of 24 h does not exceed ± 5 %.

1.2.18 The limits of tolerated complementary relative dose rate measurement error are:

- ±10 % at ambient air temperature changing over reference conditions within operational conditions;
- ±10 % at relative humidity changing over reference conditions within operational conditions;
- ±5 % at voltage changing from the reference value of 3 V in the range from 3.3 to 2 V;
- ±5 % at sinusoid vibrations in the frequency range from 10 to 55 Hz.

1.2.19 The instruments are operability under permanent magnetic field with the intensity up to 400 A/m.

1.2.20 The radiation monitors are proof against:

- ambient air temperature:

  AT6130, AT6130B from -20 to +55 °C;
  AT6130A ***with data indication***
  from -20 to +55 °C;
  AT6130A ***without data indication***
  from -40 to +55 °C;
- relative humidity at temperature of 35 °C and lower without moisture condensation up to 95 %;
- atmosphere pressure from 84 to 106.7 kPa;
- sinusoid vibration:
  - frequency range from 10 to 55 Hz;
  - moving amplitude of 0.35 mm;
- single hit:
  - peak acceleration of 50 m/s^2 (5g);
  - impact duration from 0.5 to 30 ms.

1.2.21 In packing boxes the instruments are proof against:

- ambient air temperature:

  AT6130, AT6130B from -20 to +55 °C;
  AT6130A from -40 to +55 °C;
- relative humidity of 100 % at temperature of 40 °C;
- hits, maximum acceleration of 100 m/s^2 (10 g), impulse duration of 16 ms, total number of 1000 ± 10 hits for each of three orthogonal dimensions.

1.2.22 The dimensions are 110 x 60 x 38 mm.

1.2.23 The weight (with batteries) is not more than 0.25 kg.

1.2.24 Average mean-time-between-failures is at least 10000 h.

1.2.25 Average service life is at least 10 years.

1.2.26 Average time to restore the operability is not more than 3 h.

1.2.27 According to the design of the instruments and their covering materials it is possible to decontaminate them.

1.2.28 Testing, storage, transportation and operation of the instruments do not harm the environment.

1.2.29 According to their resistance to electrostatic discharge the instruments meet CEI/IEC 61000-4-2:1995 requirements with the level of rigidity ”3” and performance factor ”A”.

1.2.30 According to their resistance to radio-frequency electromagnetic field the instruments meet IEC 61000-4-3:1995 requirements with the level of rigidity ”2” and performance factor ”A”.

1.2.31 Radio disturbance characteristic of the instruments meets CEI/IEC CISPR 22:1997 requirements.

1.3 Radiation monitor complete set

1.3.1 Radiation monitor complete set is given in Table 1.2.

Table 1.2

Name	Serial #	Q-ty	Note
1 Radiation monitor **AT6130__**		1	
2 Battery (type AAA/LR03)		2	Placed in the lateral pocket of the holster
3 Accumulator (type AAA, at least 0.7 A/h)		4	According to customer's order
4 Charger (type VARTA)		1	According to customer's order
5 IR adapter, type IR-210B		1	According to customer's order. It's possible to use similar IR adapter
6 Ear-phones		1	Stereo, ∅ 3.5 mm, according to customer's order
7 CD with the applied software 'READER'		1	According to customer's order
8 Holster		1	
9 Holder		1	According to customer's order
10 Manual		1	
11 Packing box		1	
Note - If a lot of instruments is delivered in one place it is completed with one CD-ROM.			

1.4 Design and operation

1.4.1 The radiation monitor operation is based on measuring impulse intensity generated in a gas-discharge G-M tube under detecting X-ray, gamma- and beta-radiation influence.

1.4.2 Timing distributions are transformed automatically into the direct measuring physical values (dose rate, dose, flux density). Due to the energy compensating filter the correction of energy sensitivity response in the whole range is effectively made.

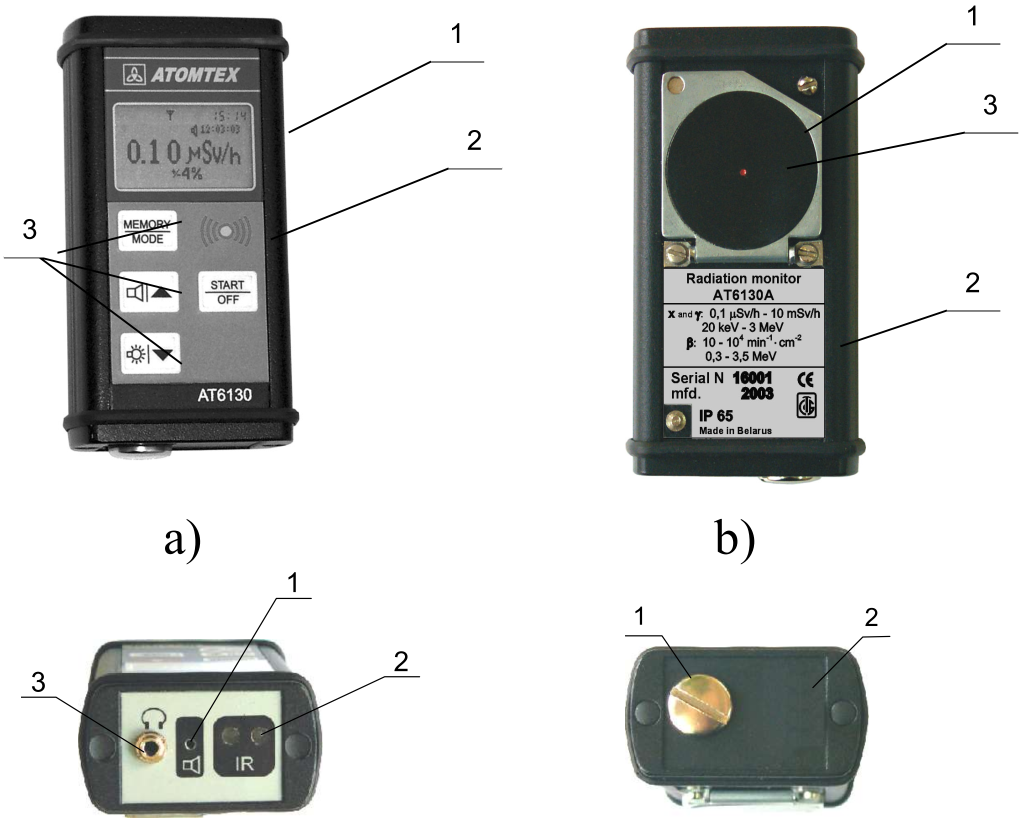
1.4.3 The control over radiation monitor operation modes, calculating, storage and indication of measurement results, self-testing are made by the microprocessor.

1.4.4 Data exchange with PC is performed by the infrared adapter IrDA, which is not included into the radiation monitor complete set, that transforms optical signals into the standard electrical ones for IrDA interface.

1.5 Radiation monitor design

1.5.1 The instrument is made in a watertight impact-resistant aluminum enclosure which is an extruded profile with separate mounting lids and sealing PVC elements.

The general radiation monitor view is given on Fig 1.1.



a) b)

c) d)

Figure 1.1 – General radiation monitor view

a) front view;
b) back view;
c) upper lid view;
d) lower lid view.

1.5.2 On the front instrument panel there are LCD (1), membrane keypad (3) and LED (2).

On the back **AT6130** side there is a convertible filter with a magnetic holder (1) and a mark of the detector center (3) and the label (2). There is no filter in **AT6130A** and **AT6130B** and the mark of the detector center is made on the instrument box.

On the upper lid there are an audible alarm hole ” 🔈 ” (1), a socket ”🎧” (3) to connect head-phones (stereo, ∅ 3.5 mm, not included into the complete set) and the window of infrared channel ”IR” (2) (not for **AT6130A**).

On the lower lid there is the cap of the battery compartment (1) and the label with the scheme of the right battery placing (2).

1.5.3 The detector (gas-discharge G-M tube) is fixed on the back instrument side, which has a window (only for **AT6130**). To protect this window from foreign stuff there are a metal grid and polymeric metallized film.

There is no window in **AT6130A** and **AT6130B** and the detector is closed with the back cover.

All the other monitor components are placed on a printed circuit card, which is fixed in reference slots.

1.6 Marking and sealing

1.6.1 The marking is made on the front and back side of the instruments.

1.6.2 The marking on the front side consists of:

- symbolic monitor notation;
- trade mark of the manufacturer.

The marking is performed with a paint by offset printing.

1.6.3 The marking of the back side is made as a label and consists of:

- trade mark of the manufacturer;
- symbolic monitor notation;
- short technical specification;
- serial number;
- year of manufacturing;
- national certification mark;
- protection class (IP);
- notice ”Made in Belarus”.

The label is made as a laminated self-adhesive label.

1.6.4 The instrument is sealed with mastic with the manufacturer’s stamp. The sealing is made on one of two mounting screws of each lid. Seals are protected with caps.

1.7 Packing

1.7.1 The instrument in a holster (from the complete set) is packed in a cardboard box. The holster is served to keep the monitor on a waist belt. The holster has buttonholes with ring to fasten the belt or lace (not included into the complete set). The lateral pocket is used to keep spare batteries. At packing the batteries from the complete set are placed in this pocket.

2 Preparation to operation

2.1 General instructions

2.1.1 The environment should not contain dust, acid and alkali steams, aggressive gases and other harmful admixtures causing corrosion.

2.1.2 Before operation learn the present manual.

2.1.3 After radiation monitor purchasing or its long-term storage inspect it on external mechanical damages, mark sharpness, IR window clearness.

2.1.4 Check the complete radiation monitor set according to the p.1.3.1.

2.2 Battery setting

2.2.1 After long-term storage, before calibration or in the case of battery discharge set new batteries. For it unscrew the cap of the battery compartment. Take out old batteries. Set two new batteries according to the polarity marked near the battery compartment. It is possible to set two accumulators, type AAA, rated voltage of 1.2 V each.

CAUTION! *Incorrect use of batteries may cause their damage. Do not use old and new batteries together. During long-term storage it is recommended to keep the batteries out to avoid the electrolyte leakage, that may cause the radiation monitor failure.*

2.3 Switching-on and off

2.3.1 To switch on the instrument press the button **"START|OFF"**.

2.3.2 The instrument starts the self-testing mode of the main modules. There is the message "ATOMTEX" on the display. If the self-testing is successfully finished, the instrument switches over a measuring mode in 3-5 s (see p.3.2.2).

2.3.3 To switch off the instrument press quickly the button **"START|OFF"** three times. There is the message ”OFF” on the display and the instrument switches off in 1-2 s.

Attention! *It is possible to switch off the instrument only from a measuring mode.*

2.3.4 If the instrument does not switch on or there is the blinking symbol "🔋" on the display or the instrument switches off in several seconds there are low batteries. Replace them according to p.2.2.

2.3.5 If there is any error during the self-testing there is the message ”Err xx” on the display where ”xx” is an error code. In this case further instrument operation is disable.

3 Monitor use

3.1 Control functions

3.1.1 During measuring the instrument can be in two possible operation modes. They are *the measuring indication mode* and *the menu mode*. That is why the control buttons are multifunctional and have double marking. The main functions of the buttons are given in the present section. Additional data are given in sections describing instrument operation modes.

3.1.2 The main function of the button **"START|OFF"** is to switch on and off the instrument (see p. 2.3):

- press the button to switch on the instrument;
- press quickly the button three times to switch off the instrument (only from *the measuring indication mode*).

The button has additional functions:

- press the button to start a new measuring in *the measuring indication mode* (for more details see sections describing measuring modes);
- press the button to confirm operation in *the menu mode*.

3.1.3 The functions of the button **"MEMORY|MODE"**:

- press the button quickly in *the measuring indication mode* to save current measurement result (for more details see sections describing measuring modes);
- press the button for long-time as long as there is another indication on the display in *the measuring indication mode* to switch over the instrument in *the main menu mode*;
- press the button in *the menu mode* to cancel operation and return to the previous menu or to cancel the main menu and start *the measuring indication mode*.

3.1.4 The functions of the button **"🔈|▲"**:

- press the button in *the measuring indication mode* to switch on/off the sound (there is a relevant symbol " 🔈 " on the display).

  Note *- The audible alarm is accompanied by the red LED (light-emitted diode) and a signal in the head-phones socket "🎧". If the sound is off there are only visual alarm (red LED) and the signal in the head-phones socket;*
- press the button in *the menu mode* to move up through the menu or a chain of values.

3.1.5 The functions of the button "☼ |▼":

- press the button in *the measuring indication mode* to switch on/off the backlighting (there is the relevant symbol "Y" on the display);

  Attention! *It is recommended to use the backlighting for 5 min at most a day to save the battery charge.*

- press the button in *the menu mode* to move down through the menu or a chain of values.

3.1.6 Only in *the measuring indication mode* it is possible to perform following commands with relevant buttons:

- switch on/off the sound;
- switch on/off the backlighting;
- switch off the instrument.

3.1.7 The button pressing is accompanied by a sound signal (if the sound is on) and the red indication (LED) on the front panel.

3.1.8 For further sections will be used one designation for a button corresponding to its function for the describing mode.

3.2 Measuring indication mode

3.2.1 The measuring indication mode is the main operation mode. There are a measurement result (with a relevant measurement unit), current date and time on the display. In the upper left-hand corner the symbol "✥" blinks once per second to notify about the radiation monitor operation.

3.2.2 After switching-on the instrument starts to indicate:

- *dose rate* for **AT6130** with closed filter;
  AT6130A;
  AT6130B;
- *beta radiation flux density* for
  AT6130 with open filter.

3.2.3 It is possible to switch over other measuring modes through *the menu mode*.

Attention! *The instrument does not stop measuring and its processing in the menu mode.*

3.2.4 The instrument **AT6130** has a filter. Its position gives specified functions and menu.
If its position is changed the radiation monitor switches automatically over the *flux density* measuring mode (when the filter is open) or the *dose rate* measuring mode (when the filter is closed) from any modes.

Attention! *Measuring starts for a new mode and old measurement result is lost.*

3.3 Menu mode

3.3.1 The multilevel menu mode is the service mode. To switch over the main menu from the measuring indication mode press the button **"MODE"** till there is the main menu on the display. To cancel the main menu press the button **"MODE"** once again.

3.3.2 Use the buttons "▲" and "▼" to move cyclically through the menu. The selected menu point is marked with the blinked symbol "►". To open necessary menu point press the button **"START"**. To return to the previous menu level press the button **"MODE"**.

3.3.3 In the menu mode where it is necessary to select a value from a chain of fixed values (e.g specify new threshold or set new date and time), move through values cyclically using the buttons "▲" and "▼". To confirm the selected value press the button **"START"**. To exit without changing values press the button **"MODE"**.

3.3.4 The menu points for **AT6130** with the closed filter are given below:

MODE
- **∑DOSE RATE**
- **∑DOSE**
- **∑BACKGROUND**
  - **∑MEASURE**
  - **∑VIEW**
- **∑DIAGRAMS**
  - **∑MEASURE**
  - **∑VIEW**

THRESHOLD
- **∑DOSE RATE**
- **∑DOSE**

NOTEBOOK
- **∑READ**
- **∑UNDO**
- **∑CLEAR**

SETTINGS
- **∑TIME**
- **∑DATE**
- **∑IR PORT**

3.3.5 The menu points for **AT6130** with the open filter are given below:

MODE
- **∑FLUX DENS**
- **∑SEARCH**

THRESHOLD

NOTEBOOK
- **∑READ**
- **∑UNDO**
- **∑CLEAR**

SETTINGS
- **∑TIME**
- **∑DATE**
- **∑IR PORT**

3.3.6 The menu points for **AT6130A** are given below:

MODE
- **∑DOSE RATE**
- **∑DOSE**
- **∑SEARCH**
- **∑DIAGRAMS**
  - **∑MEASURE**
  - **∑VIEW**

THRESHOLD
- **∑DOSE RATE**
- **∑DOSE**

NOTEBOOK
- **∑READ**
- **∑UNDO**
- **∑CLEAR**

SETTINGS
- **∑TIME**
- **∑DATE**

3.3.7 The menu points for **AT6130B** are given below:

- **MODE**
  - **∑DOSE RATE**
  - **∑DOSE**
  - **∑SEARCH**
  - **∑DIAGRAMS**
    - **∑MEASURE**
    - **∑VIEW**

- **THRESHOLD**
  - **∑DOSE RATE**
  - **∑DOSE**

- **NOTEBOOK**
  - **∑READ**
  - **∑UNDO**
  - **∑CLEAR**

- **SETTINGS**
  - **∑TIME**
  - **∑DATE**
  - **∑IR PORT**

3.4 DOSE RATE

3.4.1 The instrument is continuously measuring *dose* and *dose rate*. It is possible to switch over the instrument in the measuring indication mode through the menu. This does not affect on measurements and their processing. The measuring indication mode is started through the main menu:

MODE → DOSE RATE.

3.4.2 In the dose rate measuring indication mode there are current average dose rate value (μSv/h, mSv/h) and its statistical error (%).

3.4.3 The statistical error (from 200 to 1 %) is defined by the measurement time. More measurement results acquired for dose rate calculating better statistical error.

3.4.4 The instrument starts a new dose rate measuring at radiation surrounding changing (the accumulated dose is saved). There is a short audible and visual alarm to notify about a new measuring cycle. There is a stick-slip increasing of the statistical error that is decreasing gradually as measurement results acquire.

3.4.5 It is possible to start a new measuring cycle manually by pressing the button **"START"**.

3.4.6 There are an audible alarm (five short signals and a long pause) and the blinking symbol "(🔔)" on the display in case of dose rate threshold exceeding. If both thresholds are exceeded (dose and dose rate thresholds, p.3.5.4) two audible alarms will trigger by turns.

3.4.7 If there is the message "OL mSv/h" on the display as well as continuous audible and visual alarm it means that the dose rate measuring range is overflown (see p.1.2.1).

3.5 DOSE

3.5.1 The instrument is continuously measuring *dose* and *dose rate*. It is possible to switch over the instrument in the measuring indication mode through the menu. This does not affect on measurements and their processing. The measuring indication mode is started through the main menu:

MODE → DOSE

3.5.2 In the dose measuring indication mode there is current accumulated dose value (nSv, μSv, mSv) on the display.

3.5.3 It is possible to reset and restart the dose measuring mode by pressing the button **"START"** that does not affect on the dose rate measuring mode.

3.5.4 There are audible alarm (two short signals and a long pause) and the blinking symbol "(🔔)" on the display in case of dose threshold exceeding. If both thresholds are exceeded (dose and dose rate thresholds, p.3.4.6) two audible alarms will trigger by turns.

3.5.5 If there is the message "OL mSv" on the display as well as continuous audible and visual alarm it means that the dose measuring range is overflown (see p.1.2.1).

3.5.6 If there is the message "OL DOSE RATE" in the dose measuring mode it means that the dose measurement error is not normalized because of dose rate measuring range overflow.

3.6 FLUX DENSITY

3.6.1 It is possible to measure beta radiation *flux density* only with the radiation monitor **AT6130** (see p.3.2.4). The flux density measuring mode switches on automatically when the filter is open or through the main menu (when the filter is open):

MODE → FLUX DENS

3.6.2 In the flux density indication mode there are current flux density value (1/(min·cm^2), 10/(min·cm^2)) and relevant statistical error (%) on the display. The flux density measuring is performed with automatic background subtraction (see p.3.7).

3.6.3 The radiation monitor starts a new flux density measuring at radiation surrounding changing. There is short audible and visual alarm to notify about a new measuring cycle.

3.6.4 It is possible to start a new measuring cycle manually by pressing the button **"START"**.

3.6.5 Before starting a new beta radiation measuring cycle make sure that the background measured previously does not change greatly (see p.3.7.3). If many measuring conditions are changed remeasure the background with the closed filter.

3.6.6 Measure the background as precisely as smaller flux density value you need to measure. Matches between the lower measurement limit and background measurement time for variation coefficients of ±10 % and ±20 % are given in Appendix D. Use these data to estimate the time to measure the background and beta radiation flux density depending on estimating surface contamination.

3.6.7 When the background is measured open the filter and the instrument switches over beta radiation flux density measuring with automatic background subtraction. Place the back surface of the instrument at the distance of (15±3) mm from the surface to measure. Start a new measuring cycle by pressing the button **"START"**. It is possible to read a measurement result after reaching necessary statistical error. Less statistical error more precise measurement result.

3.6.8 There are audible alarm (5 short signals and a long pause) and the blinking symbol "(🔔)" on the display at flux density threshold exceeding.

Attention! *Please protect the detector window against metallized film damages when the filter is open.*

3.7 BACKGROUND

3.7.1 There is the *background* measuring mode only in **AT6130**, that can measure beta radiation flux density (see p.3.6). It is possible to start background measuring through the main menu when the filter is closed:

MODE → BACKGROUND → MEASURE

3.7.2 There is current background value (s^{-1}) as well as a relevant statistical error (%) on the display in this mode. When the necessary statistical error is reached save the background value by pressing the button **"MEMORY"**. At this there is the message "OK" on the display. It is possible to save background values many times during measuring.

3.7.3 It is possible to restart background measuring by pressing the button "**START**".

3.7.4 The saved background value is kept when the instrument is off. It is possible to view it through the main menu:

MODE → BACKGROUND → VIEW

3.7.5 The *background* measuring mode does not affect on *dose* and *dose rate* measuring.

3.8 THRESHOLD

3.8.1 It is possible to specify proper threshold for each of measuring quantities (dose rate, dose and flux density), see p.1.2.8). At threshold exceeding there are the blinking symbol "(🔔)" on the display and relevant alarm:

- five short signals and a long pause for *dose rate* threshold exceeding;
- two short signals and a long pause for *dose* threshold exceeding;
- five short signals and a long pause for *flux density* threshold exceeding.

3.8.2 The audible alarm at dose or dose rate exceeding triggers in any of the both measuring modes. When both thresholds are exceeded there are simultaneously two types of alarm. It is possible to disable the audible alarm by the button " 🔈 " but the symbol "(🔔)" is left on the display.

3.8.3 It is possible to specify new thresholds through the main menu (the menu point **THRESHOLD**). There is the symbol "📶" on the display.

3.8.4 It is possible to specify only the flux density threshold for **AT6130** when its filter is open. When the menu point **THRESHOLD** is selected there is the previous flux density threshold value on the display. Use the buttons **"▲"** and **"▼"** to select a new threshold value from the chain of fixed values and confirm it by the button **"START"**.

3.8.5 It is possible to specify dose rate and dose thresholds through the main menu for **AT6130A, AT6130B** and **AT6130** (when its filter is closed):

THRESHOLD → DOSE RATE
THRESHOLD → DOSE

3.8.6 The specified threshold value is lost after instrument switching-off.

3.8.7 Following fixed thresholds are specified automatically at switching-on:

30 µSv/h as a dose rate threshold;
180 µSv as a dose threshold;
100 part/(min·cm^2) as a flux density threshold.

It is possible to change thresholds in the manual mode according to the chain of fixed values divisible by 1.0, 1.5, 2.2, 3.3, 4.7, 6.8 within the dose rate measuring range from 0.1 µSv/h to 10 mSv/h; the dose measuring range from 0.1 µSv to 100 mSv and the flux density measuring range from 10 to 10^4 part/(min·cm^2).

3.9 SEARCH

3.9.1 There is the search mode in all the instruments. It is possible to perform searching with **AT6130** only when its filter is open. It gives an opportunity to perform beta radiation search as well. This mode switches on through the main menu:

MODE → SEARCH

3.9.2 In search mode there are counting rate value (s^{-1}) and the analog scale on the display (see Fig.3.1).

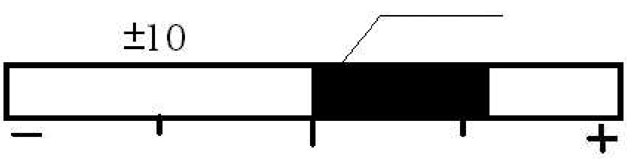


Figure 3.1–Analog scale.

The instrument operates in the counting mode without averaging (the result is updating every 2 seconds). Over the scale there is a range which the search is performed within: ±10, ±100, ±1000 or ±10000 cps. The marker on the analog scale shows the deviation of measured counts at the present time in the present place from the number of counts at the point we started searching from. The frequency of audible signals changes proportionally to counting rate within a range.

3.9.3 At approaching to a radioactive source the frequency of audible signals increases as well as the marker fills the plus region of the scale. If the source is strong audible signals become like a continuous one and the marker fills the whole right part of the scale. To continue searching press the button **"MEMORY"** and there is the message "OK" on the display. The instrument switches over a new range and the saved value is now a starting point, frequency of signals and the marker width decrease. At further approaching to the source the frequency of signals and the marker width start increasing. When the marker fills the plus region of the scale in the range ±10000 there is the message "OL s^{-1}" on the display and it is impossible to switch over the next range.

3.9.4 At moving away from the source the frequency of audible signal decreases, and the marker fills gradually the minus region of the scale. At pressing the button "**MEMORY"** the instrument saves this value of counts as a new one to search and switches over a smaller range (the marker width is decreasing).

3.9.5 For more comfortable operation in the search mode it is possible to disable the sound pressing the button " 🔈 " and connect the head-phones through the socket "🎧".

3.10 NOTEBOOK

3.10.1 It is possible to save up to 1000 *dose rate*, *dose* and *flux density* measurement results in the nonvolatile memory in the notebook mode. All results are kept in the memory in the indication format (including date and time) and saved when the instrument is off.

3.10.2 Press the button **"MEMORY"** quickly to save an indicating value in the nonvolatile memory. To notify about saving there are the symbol "✉" and a record number on the display. If the notebook is full there is the message "FULL" instead of the record number.

3.10.3 It is possible to view records in the notebook through the main menu:

NOTEBOOK → READ

If the notebook is empty there is the message "READ NO" on the display. If there are records they are read from the last-one. The symbol "✉" shows the indication mode of measurement results from the notebook. Use the buttons **"▲"** and **"▼"**

(hold them or step by step) to list records cyclically. Press the button **"MODE"** to exit this mode.

3.10.4 It is possible to delete the last record in the notebook through the main menu:

NOTEBOOK → UNDO

3.10.5 It is possible to delete all records from the notebook through the main menu:

NOTEBOOK → CLEAR

3.10.6 It is possible to read all records from the notebook through IR port.

3.11 DIAGRAMS

3.11.1 It is possible to save automatically *dose rate* measurement results in the nonvolatile memory in the diagrams mode. The maximum number of records is 1000. The results are saved in the indication format (including date and time).

3.11.2 The dose rate measurement time is selected from the chain of fixed values: 6, 60 or 600 s. The maximum operation time in this mode, when the time interval is 600 s, is about 166 h. When 1000 records are made the instrument switches off automatically in 100 s if no buttons are pressed within this time.

3.11.3 Measuring in this mode starts through the main menu:

MODE → DIAGRAMS → MEASURE

There is the symbol "ıll|" on the display. And the instrument proposes to select a value from the chain of 6 s, 60 s or 600 s using the button **"▲"** and **"▼"** and starts measuring by the button **"START"**. Press the button **"MODE"** to exit this mode.

3.11.4 In this mode measurement results are show as on Figure 3.2.

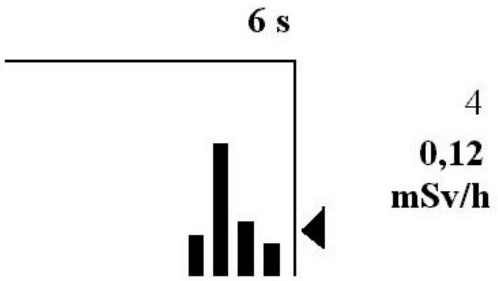


Figure 3.2

On the left display part there are columns which represent dose rate in the logarithmic scale. At recording the columns are shifted from the right to the left. The maximum number of columns on the display is 10. The dose rate value and the record number on the display represent the right last column which is marked by the blinking symbol **"◄"**. This symbol shows a measuring process.

The indication of the first measurement result appears in a selected time interval.

It is possible to stop measuring in the diagrams mode (there is no **"◄"** on the display) by pressing the button **"MEMORY"** for any time and continue measuring by pressing the same button.

It is possible to restart measuring in the diagrams mode by pressing the button **"START"** (previous measurement results are deleted).

3.11.5 Operating in the diagrams mode the instrument stops measuring when it is off or switches over other measuring modes. The acquired data are saved in the nonvolatile memory till starting new measuring in the diagrams mode.

3.11.6 It is possible to view results measured in the diagrams mode and saved in the nonvolatile memory through the main menu:

MODE → DIAGRAMS → VIEW

If there is no results measured in the diagrams mode there is the message "VIEW NO". If there are results it is possible to view them from the last-one. Use the buttons **"▲"** and **"▼"** (holding them or step by step) to list the results cyclically. The symbol **"◄"** does not blink and it shows the view mode of results. Press the button **"MODE"** to exit to the previous menu.

3.11.7 Operating in the diagrams mode the instrument measures *dose rate* and accumulates *dose*. The alarm at threshold exceeding is disable in this mode.

3.11.8 The instrument **AT6130** can measure dose rate in the diagrams mode at the temperature lower than -20 °C up to -40 °C. But in this case there is no indication on the display (the display does not work at such temperature).

3.11.9 It is possible to read all measurement results through IR port.

3.12 Date and time

3.12.1 The instrument has built-in clock and calendar. Time and date are not reset when the instrument is off.

3.12.2 It is possible to specify the time through the main menu:

SETTINGS → TIME

The instrument indicates current time in the format "xx/xx/xx" (hh/mm/ss). The blinking cursor shows a digit to modify. Use the buttons **"▲"** and **"▼"** (holding them or step by step) to list the values. To shift right press the button **"START"**. The time value changes when the value for seconds is changed. It is possible to exit this mode any time by pressing the button **"MODE"**.

3.12.3 It is possible to specify the date trough the main menu:

SETTINGS → DATE

The instrument indicates current date in the format "xx/xx/xx" (dd/mm/yy). The blinking cursor shows a digit to modify. The date is modified in the same way as the time (see p.3.12.2).

3.12.4 The date and time can be lost at battery replacing.

Attention! *If the time to change batteries is about 5 min, the date and time values will not be lost*

3.13 IR PORT

3.13.1 The instruments **AT6130** and **AT6130B** have IR port for data exchange with PC. IR port meets IrDA (Infrared Data Association) standard so it is possible to setup wireless connection with PC at the distance up to 1 m.

3.13.2 The IR port has following parameters:

- data rate is 9600 baud (bits per second);
- 8 bits in a byte;
- 1 stop bit;
- parity control is disable.

3.13.3 At switching on the IR port is off and the instrument can not communicate with PC. It is possible to switch on/off IR port through the main menu:

SETTINGS → IR PORT

Use the buttons **"▲"** and **"▼"** to switch on or off IR port and confirm it by pressing the button **"START"**. To exit this mode without any changing press the button **"MODE".**

Attention! *It is recommended to switch on IR port only for data exchange with PC to save battery charge.*

3.13.4 Main rules of data exchange between PC and the instrument:

- it is a half-duplex communication through IrDA. When data are transferring data receipt is disable and all input data will be lost;
- the instrument could not start data transferring by its-self and only by a request from PC;

- the instrument always replies to requests. If the command line has errors the instrument replies with an error message;
- the instruments interrupts data transferring at any byte when the IR port is off through the main menu. Next time when the IR port is on it is necessary to repeat the request.

3.13.5 Data exchanges using ASCII code:

- all upper case and lower case ASCII alpha symbols are equivalent for receiving data;
- the symbol LF is line feed character for receiving and transferring data, code 10;
- characters from the range 0 - 9, 11 - 32 (control characters and space) are ignored at the beginning and end of a command line.

3.13.6 The command line consists of one or more mnemonics separated by symbol ":". Command mnemonics have two forms: full and short. Upper case and lower case alpha symbols give the possibility to differ these forms. The instrument understands both forms.

3.13.7 The instruments gives an error message to the PC command which it does not recognize:

”ERR1” – the input buffer is overflown with symbols of receiving command line;

”ERR2” – the instrument does not recognize separate command mnemonic;

”ERR3” – the instrument does not recognize the command as a set of mnemonics.

3.13.8 The list of commands and their descriptions for the instrument:

IDENtify – the request to identify the instrument.
The instrument replies as a line with the model name and its serial number.
Example: "AT6130, Serial number 53".

DIAGrams:MTIMe – the request of the measurement time in the diagrams mode.
The instrument replies as a line with the time interval: 6, 60 or 600 s.
Example: "DIAGRAMS: MEASURING TIME 60 s."

DIAGrams:COUNt – the request of the number of measurements performed in the diagrams mode.
The instrument replies as a line with the number of measurements from 1 to 1000 or 0 if there are no measurement results.
Example: "3".

NOTebook:COUNt – the request of the number of records in the notebook.
The instrument replies as a line with the number of records from 1 to 1000 or 0 if there are no records.
Example: "2".

DIAGrams:FORMat – the request of the format of a measurement result in the diagrams mode.
The instrument replies as a line like "NUM DATE TIME MEAS UNIT HIGH" describing line format to show one measurement result:

NUM – measurement number from 1 to 1000;
DATE – measurement date, dd.mm.yy;

TIME – measurement time, hh:mm;
MEAS– measurement result;
UNIT – dose rate measurement units (µSv/h, mSv/h);
HIGH – height of a column (in the logarithmic scale) from 1 to 10.

DIAGrams:READ – the request to read all measurement results received in the diagrams mode.
The instrument replies as one or more lines with measurement results in the order FILO (First In Last Out).

Example:

```
"3: 23.06.02 01:20 0.73 µSv/h h=2"
"2: 23.06.02 01:20 0.07 µSv/h h=1"
"1: 23.06.02 01:20 0.73 µSv/h h=2"
```

If there are no results the reply is "NO DIAGRAMS".

NOTebook:FORMat – the request of the format of a measurement result in the notebook mode.

The instrument replies as a line like "NUM DATA TIME MEAS UNIT STAT" describing line format to show one measurement result:

NUM – measurement number from 1 to 1000;
DATE – measurement date, dd/mm/yy;
TIME – measurement time, hh/mm;
MEAS – measurement result (for relevant measuring mode);
UNIT – measurement units:
  dose - nSv, µSv, mSv;
  dose rate - µSv/h, mSv/h;
  flux density - 1/(min·cm^2), 10/(min·cm^2);
STAT – statistical error (if it is).

NOTebook:READ – the request to read all records from the notebook.

The instrument replies as one or more lines with measurement results in the order FILO (First In Last Out).

Example: "2: 23.06.02 01:20 0.43 µSv/h 5%";
"1: 23.06.02 01:20 0.10 nSv/h".

If there are no results the reply is " NO NOTEBOOK".

3.14 Decontamination

3.14.1 In case of getting radioactive dust on the instrument it is necessary to decontaminate it.

3.14.2 Decontaminate the instrument with a tissue tampon moistened in ethanol. It is necessary 10 ml of ethanol for two-times decontamination.

3.14.3 The instrument is operable in 15 min.

3.15 The list of possible troubles

3.15.1 The list of possible troubles during radiation monitor operation and trouble-shootings are given in Table 3.1.

Table 3.1

Trouble, its manifestation and additional features	**Possible reason**	**Trouble-shooting**
1 There is no display backlighting, no response to press the button at pressing	Low batteries	Set new batteries
2 There is the symbol "🔋" on the display at switching on or within operation	Low batteries	Switch off the instrument. Set new batteries
3 There is the message "ERRxx" on the display ("xx" is the error code)	Invalid EEPROM	Switch on and off the instrument several times. If the trouble is continuous call to the manufacturer
4 During operation the instrument switches off. There is no symbol "🔋" or the message "OFF" on the display	Processor failure	Switch on and off the instrument several times. If the trouble is continuous call to the manufacturer

4 Technical service

4.1 The maintenance of the instrument is performed to provide its stable operation for long time and its operability.

4.2 The maintenance consists of preventive service and periodic control of its operability at least once per two weeks.

4.3 The preventive service is performed on a working place and consists of:

- external inspection for box damages and sharpness of signs;
- removal of dust and dirt from instrument surface, display and IR window by 50 % ethanol.

The ethanol requirement for preventive service is 10 ml.

5 Storage

5.1 Before operation the instrument should be stored in a warehouse in the packing box of the manufacturer at ambient air temperature from - 10 to + 55 °C and relative humidity up to 98 % at 35 °C.

5.2 Without packing box the instrument should be stored at ambient air temperature from + 10 to + 35 °C and relative humidity of 80 % at least 25 °C.

5.3 The warehouse should not contain dust, acid and alkali steams, aggressive gases and other harmful admixtures causing corrosion.

6 Transportation

6.1 The packed instrument can be transported in any closed means of ground transport and in hermetic compartments of an airplane at ambient air temperature from - 20 to + 55 °C and relative humidity of (95±3) % at 35 °C.

7 Utilization

7.1 Radiation monitor utilization does not harm the environment.

8 Acceptance-certificate

The radiation monitor **AT6130___**,
serial # _________, corresponds to the technical specification mentioned in the present manual.

Manufacturing date ________________

Technical control ______________ stamp

9 Packing list

The radiation monitor **AT6130__**,

serial # **________**, is packed at ***SPE ATOMTEX***

Date of packing **______________**

Packer **______________________**
(signature)

The packed instrument is accepted by
______________________stamp
(signature)

10 Warranty

10.1 The manufacturer guarantees that the radiation monitor meets the main parameters and technical specification given in the present Manual if the customer performs the rules and conditions of operation, transportation and storage.

10.2 The warranty is 18 months since the date of the radiation monitor receiving by the customer or at the end of 3 weeks after the instrument shipment.

10.3 The customer has the right of free repair in the case of radiation monitor failure within warranty.

Attention *In the case of opening seals on the instrument, damaging its units and accessories by the customer any claim isn't accepted and the warranty repair isn't performed.*

10.4 The warranty is prolonged on the term from claim receiving till the date of the radiation monitor shipment.

10.5 The manufacturer provides after-warranty service of its products on contract basis when the warranty is over.

11 Reclamation

11.1 If the radiation monitor has a failure within the warranty the customer should send a reclamation by the manufacturer's address:

SPE "ATOMTEX"
5 Gikalo St.,
220071 Minsk
Republic of Belarus
Tel: (+375-17) 284-40-16
Tel/Fax: (+375-17) 232-81-42
Tel/Fax: (+375-17) 288-29-88
E-mail: info@atomtex.com

11.2 Reclamation is not sent if:

- the warranty is over ;
- the customer does not perform rules and conditions of operation, transportation and storage described in the present Manual.

11.3 All reclamations are to be registered in **Table.**11.1.

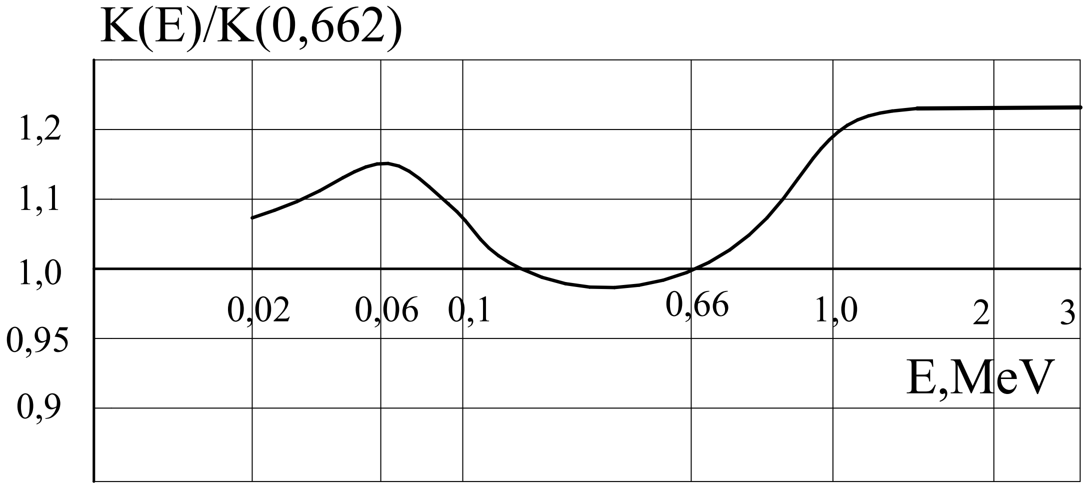
Table 11.1

Date of failure	Description	Actions	Note

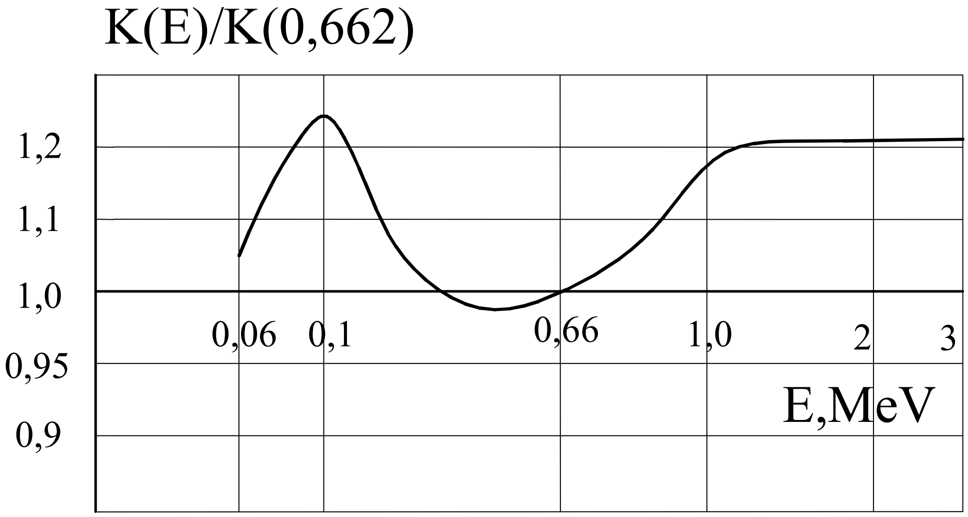
Appendix A

Standard energy sensitivity response respect to ^{137}Cs gamma radiation energy of 662 keV

AT6130

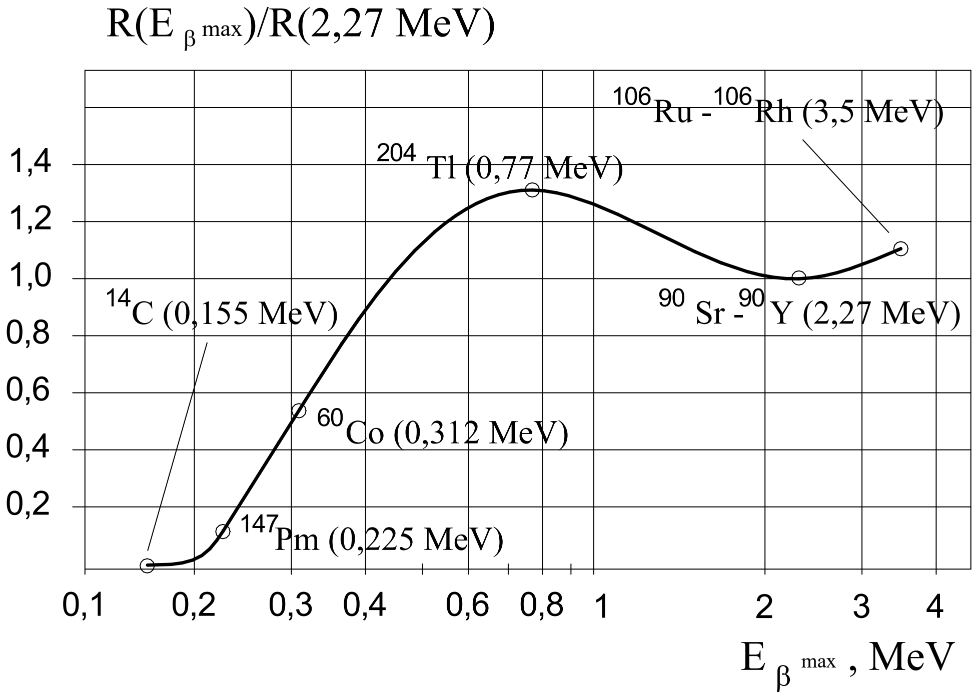


AT6130A,B



Appendix B

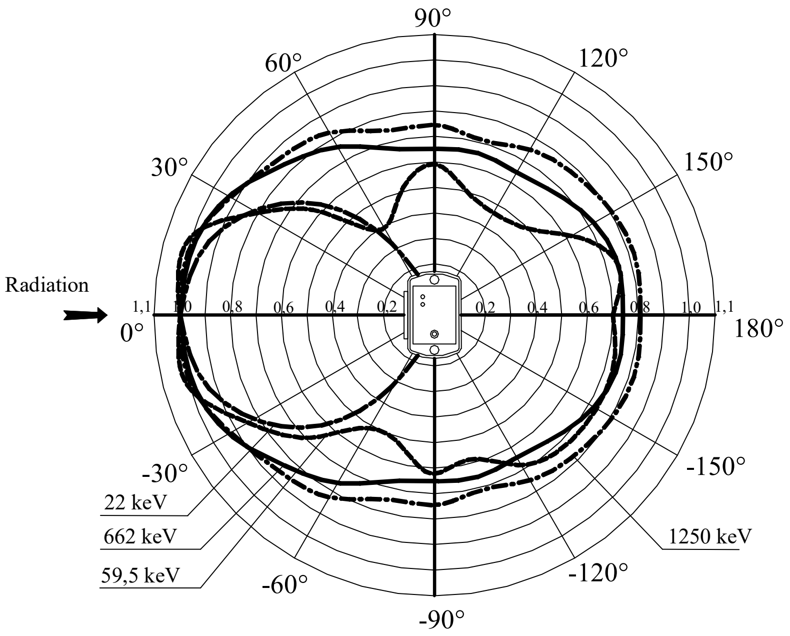
Standard sensitivity response upon maximum beta-spectrum energy at measuring beta radiation flux rate

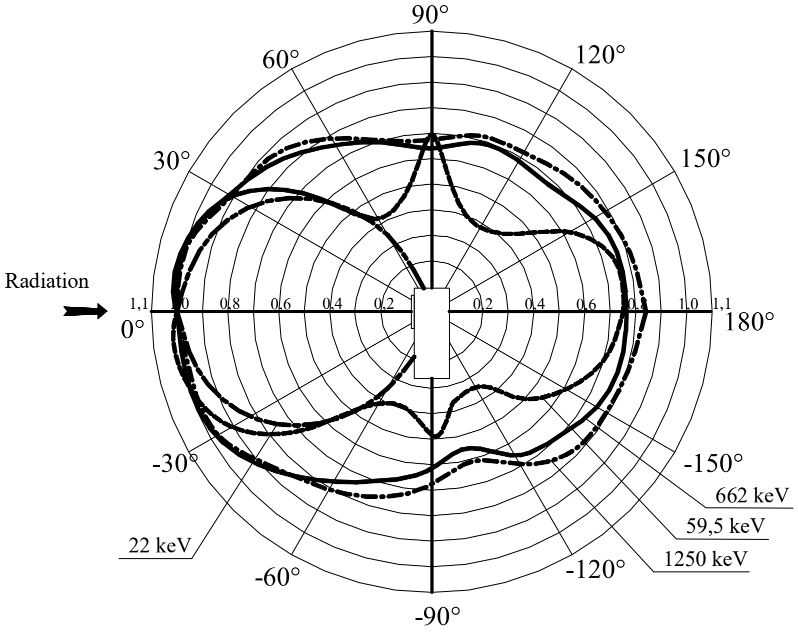


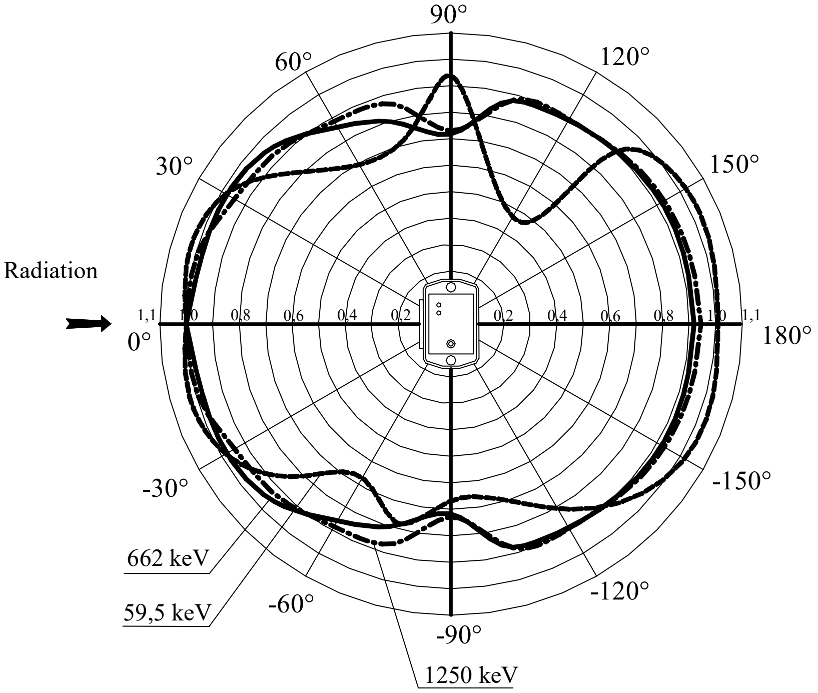
Appendix C

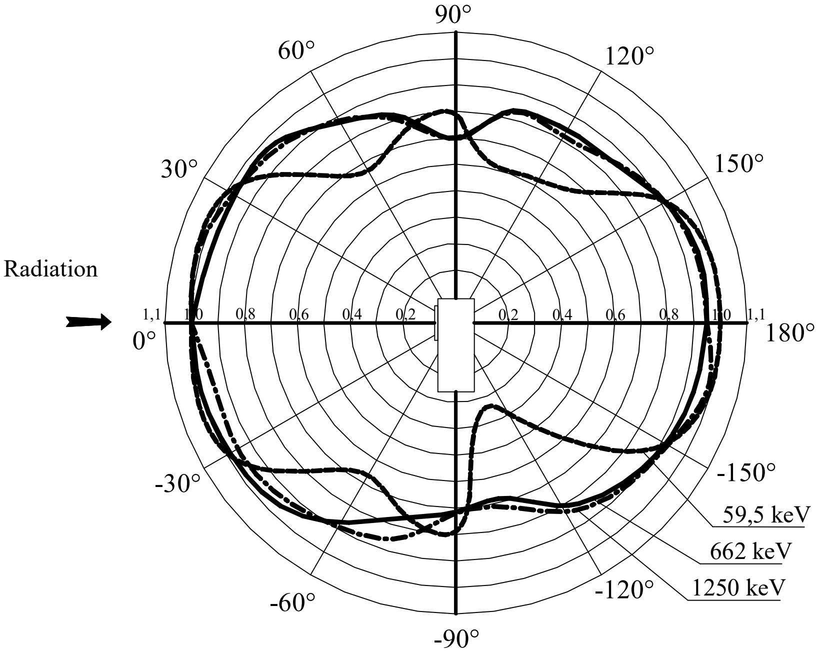
Standard sensitivity response upon gamma radiation incidence angle respect to the calibration direction

AT6130






90°
60°
120°
30°
150°
Radiation
0°
180°
1,1
1,0
0,8
0,6
0,4
0,2
0,2
0,4
0,6
0,8
1,0
1,1
-30°
-150°
662 keV
59,5 keV
-60°
-120°
-90°
1250 keV


90°
60°
120°
30°
150°
Radiation
0°
180°
1,1
1,0
0,8
0,6
0,4
0,2
0,2
0,4
0,6
0,8
1,0
1,1
-30°
-150°
59,5 keV
662 keV
1250 keV
-60°
-120°
-90°

Appendix D

Dependence of low limit of beta radiation flux rate measuring on background and flux density measuring time

$\varphi_{н}$, particle/(min·cm^2), at statistical error ±10 %														
$t_{ф}$, мин **t_{φ}**, мин	1	2	3	4	5	6	7	8	9	10	15	20	25	30
1	114	112	111	111	111	111	111	110	110	110	110	110	110	110
2	64.6	61.2	59.9	59.3	58.9	58.6	58.5	58.3	58.2	58.1	57.8	57.7	57.6	57.6
3	49.0	44.7	43.1	42.2	41.7	41.4	41.1	40.9	40.8	40.6	40.3	40.1	40.0	39.9
4	41.6	36.7	34.9	33.9	33.3	32.8	32.5	32.3	32.1	32.0	31.5	31.3	31.1	31.1
5	37.4	32.1	30.1	29.0	28.3	27.8	27.5	27.2	27.0	26.8	26.3	26.0	25.8	25.7
6	34.6	29.2	27.0	25.8	25.0	24.5	24.1	23.8	23.6	23.4	22.8	22.5	22.3	22.2
7	32.7	27.1	24.8	23.5	22.7	22.2	21.7	21.4	21.2	21.0	20.3	20.0	19.8	19.6
8	31.3	25.6	23.2	21.9	21.0	20.4	20.0	19.6	19.4	19.1	18.5	18.1	17.9	17.7
9	30.3	24.4	22.0	20.6	19.7	19.1	18.6	18.3	18.0	17.8	17.0	16.6	16.4	16.2
10	29.4	23.5	21.0	19.6	18.7	18.0	17.6	17.2	16.9	16.6	15.9	15.5	15.2	15.0
15	27.0	20.8	18.2	16.6	15.6	14.9	14.4	14.0	13.6	13.3	12.5	12.0	11.7	11.5
20	25.8	19.5	16.8	15.2	14.2	13.4	12.9	12.4	12.0	11.7	10.8	10.2	9.9	9.6
25	25.1	18.7	16.0	14.4	13.3	12.5	11.9	11.5	11.1	10.8	9.7	9.2	8.8	8.6
30	24.7	18.3	15.5	13.8	12.7	12.0	11.3	10.9	10.5	10.1	9.1	8.5	8.1	7.8

$\varphi_{н}$, particle/(min·cm^2), at statistical error ±20 %														
t$_{ф}$, мин / **t**$_{\varphi}$, мин	1	2	3	4	5	6	7	8	9	10	15	20	25	30
	33.9	32.3	31.7	31.5	31.3	31.2	31.1	31.0	31.0	30.9	30.8	30.8	30.7	30.7
	21.9	19.6	18.8	18.4	18.1	17.9	17.8	17.7	17.6	17.5	17.3	17.2	17.2	17.1
3	18.1	15.6	14.6	14.0	13.7	13.5	13.3	13.2	13.1	13.0	12.8	12.6	12.6	12.5
4	16.3	13.6	12.5	11.9	11.5	11.3	11.1	10.9	10.8	10.7	10.4	10.3	10.2	10.1
5	15.2	12.4	11.3	10.6	10.2	9.9	9.7	9.6	9.4	9.3	9.0	8.8	8.7	8.7
6	14.5	11.6	10.4	9.8	9.3	9.0	8.8	8.7	8.5	8.4	8.1	7.9	7.8	7.7
7	14.0	11.1	9.9	9.2	8.7	8.4	8.2	8.0	7.9	7.7	7.4	7.2	7.0	7.0
8	13.7	10.7	9.4	8.7	8.3	7.9	7.7	7.5	7.4	7.2	6.8	6.6	6.5	6.4
9	13.4	10.4	9.1	8.4	7.9	7.6	7.3	7.1	7.0	6.8	6.4	6.2	6.1	6.0
10	13.2	10.1	8.8	8.1	7.6	7.3	7.0	6.8	6.6	6.5	6.1	5.9	5.7	5.6
15	12.5	9.4	8.0	7.3	6.7	6.4	6.1	5.9	5.7	5.5	5.1	4.8	4.7	4.5
20	12.2	9.0	7.6	6.8	6.3	5.9	5.6	5.4	5.2	5.1	4.6	4.3	4.1	4.0
25	12.0	8.8	7.4	6.6	6.1	5.7	5.4	5.1	4.9	4.8	4.2	3.9	3.7	3.6
30	11.9	8.6	7.3	6.4	5.9	5.5	5.2	4.9	4.7	4.6	4.0	3.7	3.5	3.4

Note:

$\varphi_{н}$ – lower limit of beta radiation flux density measuring range;
t$_{ф}$ – background measurement time;
t$_{\varphi}$ – beta radiation flux density measurement time.